Strategic partnership on Artificial Intelligence between CERN, WFP, List and the Government of Luxembourg

Executive Summary

The proposed partnership between the Government of Luxembourg, the United Nations World Food Programme (WFP), represented by its Innovation Accelerator, the European Organization for Nuclear Research (CERN), via its CERN openlab programme, and the Luxembourg Institute of Science and Technology (LIST) aims to leverage state-of-the-art artificial intelligence (AI) technologies, as well as world-class talent and resources from CERN, LIST and WFP, to speed up progress towards a world with Zero Hunger. The goal of this strategic collaboration is to harness CERN's Artificial Intelligence algorithms and weather modelling framework, and LISTS's Artificial AI for Earth Observation (EO) and crop modelling expertise, coupled with WFP's programmatic capabilities, to tackle challenges around food insecurity and acute hunger. By leveraging the collective scientific and technological expertise of the partners, WFP can amplify its impact through increased efficiency and effectiveness of emergency response and development activities. The support from the Government of Luxembourg will be essential to mobilize the necessary resources on CERN, LIST and WFP's side to swiftly identify, develop, experiment and scale AI use cases impacting people with humanitarian needs and enhancing WFP operations worldwide. Furthermore, due to Luxembourg's leading role in the enablement of Artificial Intelligence, its expertise, knowledge and wide network will be a valuable asset for this partnership and for the future establishment of a longer-term support and operational facility in Luxembourg dedicated to development and application of AI technologies for humanitarian operations.
This draft proposal outlines a plan to explore 3 use cases over a 2-year strategic partnership from the initial scoping to the development of concrete pilots ready for the start of a scaling phase. The use cases and the underlying technologies will contribute to the advancement of the state of the art towards the realization of a "Digital Twin" concept (combined virtual model of a physical system or process and the physical data generated by such system or process) to facilitate faster, data-driven, scenario-based, decision-making process at WFP and other humanitarian actors.

Introduction

The WFP Innovation Accelerator

The WFP Innovation Accelerator sources, supports, and scales high-impact innovations to achieve Zero Hunger. Based in Munich, Germany, the Innovation Accelerator provides WFP's employees, social entrepreneurs, and startups with funding, hands-on technical assistance and support, and access to WFP's global operations. Through the Accelerator, WFP is leveraging unprecedented advances in frontier innovations - such as mobile technology, artificial intelligence, machine learning, big data, blockchain, web3 and robotics - and new business models to transform the way WFP serves vulnerable communities across the world.

The CERN openlab programme at CERN

The European Organization for Nuclear Research (CERN) is widely recognised as the world's leading laboratory for particle physics. Technologies developed at CERN have historically gone on to have a significant impact through their applications in wider society. The CERN Information Technology Department has created in 2001 its CERN openlab programme, a public-private framework to design and implement joint R&D projects with industry, academia and public entities to address complex computing and data science challenges. Although the initial focus of the programme was to support the High-Energy Physics experiments at CERN, today CERN openlab supports the applications of emerging technologies such as Artificial Intelligences, high-performance computing architectures, large-scale data storage, and Quantum Computing to different scientific domains from physics to healthcare, biology, and climate research. CERN and WFP have signed in 2023 a Collaboration Agreement to join forces in the advancement of technology applications to humanitarian challenges.

The Luxembourg Institute of Science and Technology (LIST)

The mission of the Environmental Research and Innovation (ERIN) department of the Luxembourg Institute of Science and Technology (LIST), a research and technology organization, is to carry out responsible impact-driven research and technological innovation & policy support for a sustainable resources management and the reduction of environmental impact of human activities, in order to enable and accelerate the transition towards a sustainable, resilient and digital economy and society in Luxembourg and abroad. The ERIN department is especially experienced in integrating Earth observation data with in-situ measured data, land surface models and satellite and terrestrial communication services in order to provide evidence-based decision support tools in near real time in a variety of thematic domains (i.e. disaster management, food security, natural resources management, maritime surveillance) of relevance for defence, civil security and humanitarian aid needs.

Luxembourg's Partnership with the Innovation Accelerator

Luxembourg and WFP have a longstanding partnership, and the Innovation Accelerator has been thrilled to continue that relationship through a multi-year agreement until 2025. Furthermore, the Government of Luxembourg was the main supporter of the Humanitarian Innovation Accelerator (HIA) programme to enhance emergency management and access to services through the use of approaches in Artificial Intelligence and data science, space and satellite technology, supply chain and logistics. The programme concluded in a 2-day event in Luxembourg, where the selected ventures met with potential funders, government officials and industry leaders. The Innovation Accelerator and Luxembourg share a common interest in championing technology and innovation

in the humanitarian sector in order to create lasting change for those most in need. Through Luxembourg's support, the Innovation Accelerator was able to invest in Frontier Innovations, including support to projects such as WFP-X and the Building Blocks project in Jordan and Bangladesh. The Frontier Innovations' team is at the forefront of technological innovation, such as artificial intelligence and machine learning, developing advanced technological solutions to improve WFP's impact for the most vulnerable people around the world. As WFP is the co-chair of the UN Innovation Network and a member of the HLCM Task Force on the use of AI in the UN system, the learnings from this strategic collaboration could be shared through these networks as well.

Luxembourg's strategic alignment, strong humanitarian commitment, and robust innovation ecosystem make it an ideal partner for CERN, LIST and WFP. As a leader in digital innovation, Luxembourg's focus on cutting-edge technologies aligns seamlessly with this initiative, which aims to harness artificial intelligence to enhance humanitarian response. As part of its National Strategy for Humanitarian Action, Luxembourg prioritizes adapting to the evolving nature of humanitarian crises, particularly those fueled by climate change and conflict. It will do so by leveraging these technologies to explore improvements in damage assessment, food security monitoring and financial aid monitoring and assurance in humanitarian settings.

Furthermore, Luxembourg's commitment to data privacy and security, as exemplified by its Data Embassies initiative, aligns with this initiative's emphasis on safeguarding sensitive data in humanitarian operations. This commitment ensures that the AI solutions, developed through this partnership, will adhere to stringent data protection principles, fostering trust and transparency amongst beneficiaries and stakeholders within the United Nations and broader humanitarian community. Moreover, Luxembourg's commitment to open data and transparency (LNDS) will facilitate the sharing of data and insights among project partners, ensuring that the benefits of this collaboration are widely disseminated and utilized to enhance humanitarian response efforts worldwide.

[Add paragraph describing how the collaboration could foster the establishment of a longer-term presence in Luxembourg of a hub for development of AI for humanitarian challenges]

[Add cross-referencing with other ongoing activities and discussions]

Open Science, Responsible AI, goals

open science policies, responsible technology, sharing, SDGs, etc.

Objectives and overall expected impact

The primary outputs of this collaboration are as follow:

a) Develop a roadmap for the development of prioritized use cases leveraging CERN's and LIST's expertise and WFP's programmatic activities to enhance impact at scale

b) AI solutions at the MVP stage, with assessment of usage by real end users
c) Generate and share lessons learned on the development of AI use cases for the humanitarian context
d) Evaluate the cumulative impact of the various use cases for the development of the building blocks of a future digital twin of WFP operations.

Use cases

Following the workshop between WFP, CERN and representatives of the Luxembourg Government in December 2023, and follow-up discussions with the LIST beginning of 2024, an initial list of use cases was defined as the base of the work of the collaboration. It is important to note a more in-depth assessment of the use cases and the appropriate solutions will have to be done at the beginning of the partnership.

Use case 1: Damage Assessment and Prediction Platform (DAPP)
Lead partner: List – Contributors: CERN, WFP

This use case proposes to extend the WFP SKAI platform with additional capabilities in terms of object detection, supported data types, reliability, scalability and performance, and to integrate in the platform additional modelling and prediction capabilities by including short/medium-term weather modelling and forecast. The combination of existing and new technologies being developed by CERN, LIST and WFP will form an initial proof-of-concept of "multi-modal digital twin" able to use physical data (images and sensor data) with AI-based simulations moving towards the vision of having decision-support systems using data from different domains.
This use case is organised in four sub-cases

1. **Construction damage assessment system (LIST)**: extension of the current platform capabilities from buildings to additional man-made objects (bridges, roads, etc.) and different types of satellite and sensor data in different range of frequencies (optical, radar, etc)
2. **Crop damage assessment and yield prediction (LIST)**: similar in concept to the previous sub-case, this sub-case extends the platform capabilities to natural artefacts like crops and models their evolution over time based on defined scenarios
3. **Weather modelling and forecast (CERN)**: this sub-case extends and adapts the existing AI-based weather modelling capabilities of the CERN EMP2 project to parameters and time-ranges of interest for man-made and natural objects damage predictions
4. **Damage Assessment Digital Twin (CERN):** the final integration of the previous building blocks in a Minimum Viable Product of digital twin for damage assessment as a proof-of-concept for decision-making and prevention.

Use case 2: Anomaly Detection for Cash-Based Transfers (AD4CBT)
Lead partner: WFP – Contributors: CERN
This use case proposes to adapt the CERN multi-format anomaly detection algorithms used for physics data monitoring and analysis to WFP Cash-Based Transfer system. The goal is to provide

early detection of misuse of cash transfers and gradually extend the detection for different systems (e.g. vouchers) and types of frameworks (e.g. insurance contracts).

Use case 3: Federated Learning Infrastructure for Sensitive Data Processing (FLI4SDP)
Lead partner: CERN – Contributors: WFP, LIST
This use case proposes to adapt the CERN federated learning platform (currently used for healthcare applications) to enable the training of AI models using data from multiple organizations for a broad range of applications. A suitable set of applications will be defined by WFP and also identified in collaboration with other organization currently looking for secure way of processing sensitive data.

A detailed explanation of these 4 potential use cases is included in appendix 1. Once developed and deployed, these use cases will constitute the building blocks of a Digital Twin platform able to process different types of data, flexibly support different use cases, and ultimately provide a faster, data-driven, scenario-based decision-making process at WFP and possibly other humanitarian actors.

[Add impact of the outcomes of the project on the existing initiatives described in the strategy section and their further evolution]

Project phases and timelines

To achieve the stated objectives, the following phases would be undertaken for each use case:

1. Mapping of the existing tools/methods, assessment of initial readiness level
2. Use case planning and framing
3. PoC development
4. MVP development and impact assessment
5. Larger scale MVP development, initial generalizability and scalability assessment

Each phase includes a reporting task to describe the outcomes and the inputs to the following phase.

In order to cover multiple use cases and different contexts (e.g. use case maturity and complexity), the duration and timing of each use case would be planned at the start of this partnership.

[Add Gantt Chart]

The proposed timeline for the collaboration is as follows: (**Note: After the use case prioritization phase, Activities 2-14 have to be taken on by a separate team for each use case.**)

Year	Month	Duration	Project phase	Deliverables

Y1	M1-12	Throughout the project	**[A0]:** Governance and project meetings	
	M1	1 month	**[A1]**: Use case prioritization and framing	
	M2-4	3 months	**[A2]**: Proof of Concept development	
	M5-8	4 months	**[A3]**: Minimum Viable Product development and impact assessment	
	M9-12	4 months	**[A4]**: Larger scale MVP development, initial generalizability and scalability assessment	
Y2	M1-12	12 months	*Repeat Y1 activities for the next wave of use cases*	

Communication, Dissemination, Outreach

Comms/outreach material: project name/branding, logo, infographics, templates
Comms plan: key messages and objectives, preliminary list of events
Common set of publication/dissemination rules and acknowledgements

Partners Roles and Contributions

On top of their strategic alignment WFP, CERN, LIST and the Government of Luxembourg will play key and complementary roles in this project:

- WFP will contribute to project management, technical development, application definition, impact assessment, humanitarian domain expertise and cloud infrastructure;
- CERN will lead use cases 2 and 3, contribute to technical development, technical domain expertise and initial operations of the pilot infrastructure;
- LIST will lead use case 1, contribute to technical development, technical domain expertise and research;
- Luxembourg will provide financial support and play a leadership role in ensuring the project's success mobilizing its innovative and technology ecosystem, leveraging its national experience, infrastructures and capacities, as appropriate.

To ensure alignment and transparency across all partners, periodic meetings will be held over the period of collaboration between WFP, CERN, LIST and Luxembourg.

Resources required

To ensure the successful implementation and completion of the project, it is crucial to secure the necessary financial, business and technical resources. We propose exploring avenues for funding through collaboration and joint efforts:

1. Luxembourg Financial Support: We kindly request Luxembourg's collaboration in mobilizing the required funding for this project. Given Luxembourg's alignment with the initiative's goals, a Luxembourg financial contribution would be instrumental to enable the project's feasibility and impact.

2. CERN estimates that the resources required to implement its participation in the use cases are up to 3 technical development FTEs. Technical supervision, project management and computing resources need for development are provide as in-kind contributions.

3. LIST will provide research and development resources relevant for the use cases selected.

4. The WFP Innovation Accelerator will provide 1 technical development resource, 1 project management resource, 1 business analyst resource, access to the Cloud Environment (AI Sandbox environment), access to the corresponding Business stakeholders and data sharing services that comply with WFP standards.

Our combined efforts will be instrumental in driving the project's success and should be jointly agreed on prior to the project's formalization.

Estimated budget

The estimated budget for this collaboration, considering the nature of the deliverables and timeline for **on average 2 selected use cases in parallel per year (to a total of 3-5 use cases tested, piloted and potentially scaled, subject to results, over a 2 years' period)** is presented in the table below:

Budget line	**Description**	**Estimated Cost**
1	CERN FTEs, including management costs	400k
2	LIST FTEs	400k
3	WFP FTEs	400k
4	Data & Infrastructure - allocated to WFP	150k
5	WFP Legal, Finance and Knowledge management fee	150k
A	**Yearly Total**	**1.5 MEUR**
B	**Total for 2 years**	**3.0 MEUR**

The above budget is a preliminary estimate that includes direct and indirect support costs, and can vary based on the specific requirements, level of detail, and complexity and scale of the project. The exact figures will be finalized based on the agreed scope of work and availability of resources, agreed between the parties.

Conclusion

The proposed partnership between WFP, through its Innovation Accelerator and CERN, LIST, and the Government of Luxembourg, aims to develop, pilot, test, scale and assess the impact of AI solutions and use cases, identifying effective approaches to improve the lives of the growing number of people with humanitarian needs. The requested technical resources from CERN and LIST, financial resources from Luxembourg and the WFP Innovation Accelerator programmatic, technical, and operational resources will enable the successful execution of this initiative. This marks an important step towards leveraging technology assets and talent developed in cutting-edge public institutions for the humanitarian space. Solutions that are born with openness, transparency and sustainable principles built in from the start, with potential to increase efficiency and effectiveness of humanitarian work worldwide.

Note: This concept note has been prepared for discussion purposes and is subject to further refinement, based on further discussions and mutual agreement between WFP, CERN, LIST and the Government of Luxembourg.

Appendix

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Appendix 1: Overview of proposed use cases

Use Case Template

Application challenges (including operational) (WFP)
State of the art/background (UC lead)
Technical solution/development (how) (UC lead)
Proposal of deliverables (what)
Expected Impact (WFP)

Potential use case #1: Augmented building damage assessment capabilities

Among WFP Innovation Accelerator's cutting-edge projects, SKAI stands out as a remarkable example, harnessing AI for effective damage assessment using very high-resolution imagery. It has been utilized to assess several major disasters since 2022. However, since it relies on very high-resolution optical imagery (VHR Optical), it is subject to a type of imagery with limited collection frequency and low robustness to weather. Radar technology was pointed as an alternative source of data that can reduce the satellite revisit time if combined with optical one (i.e. Lower time between collection of two images from the same point in Earth) and more robust to weather (E.g. Presence of clouds may undermine the usage of very high-resolution optical imagery). Then, the necessity to development of AI-based change detection algorithms that enable the handling of multitemporal heterogeneous data sets, meaning that surface changes are detected and interpreted by comparing EO data from different sensors with different modalities and spatial resolutions. Drone and aerial imagery on the other hand, can be deployed ad-hoc for timely collection of data for fast assessment, without relying on orbits of specific image collection satellites. Even though tradeoffs may exist (e.g. VHR optical may be more accurate or scalable), a complementary approach between VHR optical, multispectral images and drones may be possible and is encouraged.

1. **Construction damage assessment system (LIST)**
2. **Crop damage assessment and yield prediction (LIST)**
3. **Weather modelling and forecast (CERN)**
4. **Damage Assessment Digital Twin (CERN)**

Hypothesis of impact: A complementary Radar-based assessment may (A) enable assessment in contexts that were not previously covered by SKAI and (B) improve adoption in contexts where SKAI was technically feasible. As a reference, if employed, SKAI has an estimated time of assessment 13 times faster and 77% cheaper than traditional damage assessment approaches.

Examples of impact:

- *Total savings = (# of total emergencies assessed) x (% of emergencies assessed by AI) x (% efficiency factor per assessment made by AI)*
- *Faster response time per person in emergency situations*
- *More people detected as in need for emergency response*

Potential use case #2: Crop damage assessment

Sustainable progress of poor rural people depends on building a more robust asset base, often partially formed by crops. Assessing the level of risk and shocks that occur to these live assets are essential for addressing and mitigating them, to ensure a better quality of life for these populations. This strengthening becomes increasingly important in a context of growing environmental sustainability and climate resilience concerns, and solutions based on satellite imagery can help fulfill this need. The coverage, scalability and detail of satellite data sources make them a great candidate for large scale assessments of such scattered diagnostics.

Hypothesis of impact: Correct, timely and geographically granular crop damage assessment can lead to preventive measures and faster post-event responses to tackle food insecurity. From the preventive perspective, a satellite-based crop damage assessment may be used to assess damages that may lead to food insecurity later in the crop lifecycle (i.e. Minor damage early on lead to lower productivity). This may be fed to a more holistic solution for food insecurity prediction such as WFP's FamPred. Crop damage assessment can also be used to provide timely diagnosis of recently occurred natural disasters, which may speed up responses of short-term food insecurity (i.e. Disaster damages crops close to be harvested) or inform insurance products that cover crop damage.

Examples of impact:

- *Total savings = (# of households covered) x (% of households that adopted preventive measure due to crop damage assessment) x (difference between preventive measure vs reactive measure per household)*
- *Faster response time per person with crop damage*
- *More people people detected as in need due to crop damage*

Potential use case #3: Cash-based transfers (CBT) Anomaly detection

WFP is the largest agency delivering humanitarian cash. In 2021, WFP transferred a record-high US$3.3 billion in cash-based transfers and commodity vouchers to 56 million people in 72 countries - up from US$10 million in 10 countries in 2009. The last decade not only witnessed a significant surge in WFP’s use of cash programming but also a matching rise in the complexity and intensity of organization-wide investments to improve cash efficiency and effectiveness, as well as a constant evolution of trends in the humanitarian sector.

Studies show that food and nutrition requirements can only be meaningfully addressed when a household's range of essential needs are addressed at the same time. The poorest households

often spend 60-70 percent of their income on food. A family that receives cash in a dollar value calculated for food items alone may use it to cover other essential requirements and then fall short in food security. By providing cash to cover multiple essential needs, we are ensuring that households have more resources to meet their food 8 and nutrition requirements, advancing our goal to end hunger (SDG2), as well as contributing to other SDG targets.

The vast amount of data data that is generated to support multiple CBT operations throughout the globe may offer valuable insights over the efficiency and correctness of WFP's cash assistance. A more sophisticated anomaly detection solution for CBT, examining people registration data and cash transactions, may lead to a substantial increase of efficiency and reduction in funds lost to fraud, identity theft and others.

Hypothesis of impact: A more sophisticated anomaly detection model, that leads to a few percentage points more detection of fraud and identity theft cases among all the CBT transactions may lead to direct savings involved in this type of misconduct.

Example of impact:

- *Total savings = (# of total transactions) x (% of transactions scanned) x ((% of anomalies **correctly** detected) x ($ per anomaly **correctly** detected) - (% of anomalies **incorrectly** detected) x ($ per anomaly **incorrectly** detected))*
- *Additional people receiving CBT = (Total $ saved due to fraud prevention) / ($ quota per person)*
- *Reduced reputational risk for WFP*

Potential use case #4: Development of technologies to enable training AI models using data from multiple organizations (i.e. Federated Learning)

With the growth of humanitarian challenges, AI technology and data systems, there has been a growth of humanitarian actors collecting, storing and aggregating public and private data in order to support new capabilities and improve existing ones. This collective effort could generate positive spillovers, as data collected from one organization through its operations could be leveraged by another organization to drive positive impact more effectively. However, data privacy and security concerns arise when designing data collaboration processes and systems. From the privacy perspective, aggregating multiple data sources can enable identification of individuals through triangulation. From the security perspective, moving data from one system to another may increase the risk of generating vulnerabilities in the data access. On the other hand, traditional AI development relies on aggregation of large volumes of data, from multiple individuals and multiple data sources for each individual and has the potential to generate large efficiency gains in multiple areas of humanitarian organizations.

Although a seemingly impossible balancing act, Federated learning proposes a partial solution to this challenge. Instead of moving all the data sources into a centralized environment, it trains an AI model in a decentralized manner. It does this by training parts of the model at each individual

(e.g. multiple mobile phones) or organization (e.g. multiple corporate cloud environments), where the data is located, then shares only the learnings - without containing raw data - at a global model. This greatly reduces the data privacy and security risks involved, while enabling some collaboration between multiple organizations and individual data sources.

Hypothesis of impact: Federated learning has the potential to enable training of AI models that rely on data sources from multiple organizations, as well as potential reduction of privacy and security risk of existing use cases that deal with sensitive data.

Examples of impact:

- *Enabling collaboration of data for training AI models between different organizations*
- *Enabling impactful use cases that are currently constrained by data security and privacy risks*
- *Reduced data security and privacy risk for WFP for specific use cases*

All use cases listed above seek to align CERN analytical expertise and WFP strategic goals and were discussed during a workshop in December 2023 between CERN, WFP and Luxembourg government. These use cases are subject to WFP prioritization and others may be considered in their place.